23-1 REINFORCED CONCRETE BOX CULVERT DESIGN

Extension of existing reinforced concrete boxes (RCB's) or increase in overfills over existing RCB's must be given careful consideration. The assumptions made on RCB designs prior to 1977 have been modified, based on Caltrans culvert research program. Prior to 1977, the previous designs considered only a 30% side pressure. Caltrans culvert research had resulted in the application of load factor design and the establishment of two design conditions of loading for reinforced concrete box design, i.e., 22.0 kPa/m V : 22.0 kPa/m H, 22.0 kPa/m V : 6.6 kPa/m H. A recent review of RCB design parameters resulted in a change in design loadings and allowable shear in the concrete. The two design conditions of loading are now 22.0 kPa/m V : 15.7 kPa/m H, 22.0 kPa/m V : 5.5 kPa/m H. The allowable shear in the concrete has been reduced from $3.5\sqrt{f'c}$ to $3.0\sqrt{f'c}$. The standard plans for reinforced concrete boxes may be used until they are updated. Special designs should incorporate the latest design parameters.

Existing RCB's which will have additional load placed on them should be checked for structural adequacy. These box culverts should meet present design standards. If the RCB will have no additional load placed on it and it shows no apparent signs of structural distress, it will not require a structural analysis. All extensions will be designed to present design standards.

RCB's, based on service load design prior to 1977, have, in some cases, provided a reserve design capacity. The introduction of P-13 loadings had a negligible effect on the evaluation of existing RCB's. The side wall capacity in larger size RCB's is usually the weakest "link" of existing RCB's under current loadings and needs special attention.

A design review should be made when an increased loading is proposed over an existing RCB culvert. For unusual structures, the Underground Structures Technical Specialist should be consulted. The age, strength, and physical condition of the existing culvert should be considered. In addition, some existing RCB's may have been designed only for an H15 load. "As-Built" drawings may be available from Headquarters (1120 N Street). If "As-Built" plans are not available, but the year of the design or construction is known, previous standard plans can be referenced (located in the Underground Structures Unit). If none of the above are available, core samples or other means of determining strength may be necessary.

Supersedes Memo to Designers 23-1 (Metric version) dated June 1996.

An analysis of the existing RCB should be made following procedures in Chapter 6, Underground Structures, *Bridge Design Practice*; and design criteria in *Bridge Design Specifications*, Section 6 – Culverts, and Section 17 – Concrete Culverts.

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